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Women's Gainful Employment in 'Gher' Farming System (Prawn–Carp–Rice Integrated Culture) in Bangladesh: Trends and Determinants

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ABSTRACT

The paper examines trends in women's gainful employment in 'prawn-carp' and 'high yield variety (HYV) rice' enterprises of the 'gher' farming system and jointly identifies the determinants of employing female and male labour in these enterprises using a farm-level panel data of 90 producers covering a 14-year period (2002–2015) from southwest Bangladesh by applying a multivariate Tobit approach. Results revealed that women's gainful employment and real wage increased significantly with a substantial reduction in wage gap between female and male labour. The decision to employ female and male labour was found to be positively correlated thereby confirming jointness in decision-making and validity of our chosen approach. Prices and socio-economic factors exerted varied influences on female and male labour demand. Output prices, cultivated area, education and experience positively increased women's gainful employment whereas larger family size reduced it. Policy implications include investments in education targeted at the 'gher' faming households and land reform policies to consolidate farm size and facilitate smooth functioning of the land market to increase women's gainful employment.

Key Words: Women's gainful employment, 'gher' farming system, socio-economic determinants, multivariate Tobit model, Bangladesh.

1. Introduction

Although economic growth is considered as important for poverty reduction, productive employment is essential in transmitting benefits of economic growth to poverty reduction (Islam, 2006). In this respect, women's employment can play an important role (Rahman and Islam, 2013). While labour is an important factor of production, heterogeneity of labour exists due to gender and

skill differences and factors influencing demand for and supply of female labour can be different from those for males, and therefore it is important to examine gender differences in employment (Rahman and Islam, 2013).

Female labour force participation rate is generally lower in South Asia compared to East and South East Asian countries within Asia (Rahman and Islam, 2013). For example, female labour force participation rate in Pakistan is 23.2% in 2011 (Shaheen et al., 2015), 32% in India in 2012 (Sorsa et al., 2015) and 33.5% in Bangladesh in 2013 (LFS, 2015) as compared to 63.2% in Thailand in 2013 (Matsumoto and Bhattacharya, 2014) and 53.6% in Malaysia in 2014 (LFSR, 2015). Also changes in the definition and improvement in data collection methods influence these estimates. For example, a change in the definition of women's work resulted in an increase of female labour force in Bangladesh from 3.2 million in 1986 to 21 million in 1989 (Rahman and Routray, 1998). However, with the refinement of definition in subsequent Labour Force Surveys, the estimate of female labour force aged 15+ years in the rural areas dropped to 7.6 million in 2003 and then gradually increased to 13.1 million in 2013 (LFS, 2015). Rahman and Islam (2013) also noted a steady increase of the female labour force participation rate from 14.0% in 1991 to 36.0% in 2010. A recently conducted large-scale survey estimated female labour force participation rate in the Feed the Future (FTF) zone, located in the southern region of Bangladesh, at a high 60.2% (Ahmed et al., 2013).

Agriculture continues to play an important role in developing economies as a source of employment and livelihood and women continue to supply large share of labour force to support the sector (FAO, 2006). Previously women's involvement in agriculture, defined as the percentage of economically active women working in agriculture, was generously estimated at 50% globally and as high as 60–98% in Bangladesh, Bhutan, Cambodia, China, India, Myanmar, Nepal, Pakistan

and Vietnam during 2000 (FAO, 2006). However, a reassessment in recent years revealed that women accounts for just over 40% of the agricultural labour force (or economically active in agriculture) in the developing world in 2010 and 50% in Asian and African economies with high variation amongst individual countries (FAO, 2011).

In addition to crop agriculture, freshwater prawn (*Macrobrachium rosenbergii*) farming is gaining importance in recent years in Bangladesh, mainly in the coastal regions, because it is capable of not only generating higher revenue for the farmers but also earning foreign currency through exports (Rahman et al., 2011). Prawns and shrimps are the 2nd largest export item after readymade garments. According to FRSS (2012), Bangladesh exported 54,891 t of prawns and shrimps worth USD 446 million in 2010/11, of which 30% of total was prawns. Ahmed and Flaherty (2013) noted that if existing low-intensive prawn farming system can be expanded by only 10% and 50% of the potential area of 55,000 ha in the southwest region, the country could earn an additional revenue of USD 14 and USD 70 million annually.

Rahman (2000) refuted the conventional view that women in Bangladesh are involved only in postharvest processing. In fact, female labour accounts for a substantial 28% of the total labour use in field crop agriculture ranging from 11–18% in cereals and 14–48% in non-cereals in Bangladesh (Rahman, 2010; 2000). However, most of these female labour input in agriculture were supplied by the family and the incidence of women's gainful employment (i.e., employed as hired labour and getting paid either in cash or kind) was very limited, estimated at just under 2% of total labour (Rahman, 2000), implying that the share of income/benefits derived from the agricultural sector remains skewed in favour of men, despite high level of female labour force participation rate reported in national statistics.

Kabeer and Natali (2012) noted that there is persuasive evidence that gender equality in

education and employment contributes to economic growth. Furthermore, Kabeer et al. (2013), drawing on from in-depth pathway studies in Egypt, Ghana and Bangladesh, noted that women's paid work outside home/farm is more likely to be empowering than paid and unpaid work within the home. Therefore, it is imperative that women's gainful employment in agriculture is essential as it is one of the dominant sectors contributing 23.5% to national income and employing 62% of the labour force in Bangladesh (MoA, 2008) to promote inclusive growth (Kabeer et al., 2013) and reduce poverty (Rahman and Islam, 2013).

About 60–70% of the freshwater prawn farming in the southwest region of Bangladesh is conducted within a 'gher' farming system that incorporates joint operation of two key enterprises: freshwater prawn-carp and High Yielding Variety (HYV) Boro (dry winter season) rice (Rahman et al., 2011). The locally used term 'gher' refers to the modification of rice fields by building higher dikes around the field and excavating a canal several feet deep inside the periphery to retain water during the dry season (Kendrick, 1994). The system is labour intensive as the 'gher' dikes and trenches need substantial repair almost annually in addition to labour inputs needed to produce prawn, carp and HYV Boro rice (Rahman et al., 2011). Therefore, the sector provides great opportunity to enhance women's gainful employment as hired labourer so that women can also share the benefits accruing from this highly labour intensive and yet profitable enterprise.

A large body of literature exists on women's employment issues in Asia (e.g., Rahman and Routray, 1998; Rahman, 2000; Ahmed et al., 2013; Hussain et al., 2012). But a major limitation of literature examining women's actual involvement in agriculture in Bangladesh (e.g., Rahman and Routray, 1998; Rahman, 2000; Rahman, 2010; Rahman et al., 2011; Ahmed et al., 2013) or paid employment in Asia (e.g., Hussain et al., 2012; Shaheen et al., 2015) is that these are cross-sectional studies. Such studies are only capable of providing a snapshot of the existing situation

but cannot reveal information on the dynamics of women's involvement in work over time and their determinants, knowledge of which is essential in order to promote women's gainful employment. Also in the process of identifying the determinants of women's employment, existing research concentrated on analysing use of female labour independently from male labour (e.g., Rahman and Routray, 1998; Rahman, 2000; Hussain et al., 2012; Shaheen et al., 2015), although in reality producers may hire both male and female labour in their production process implying jointness in decision making. Furthermore, identification of factors influencing female and/or male labour employment in this highly profitable and unique 'gher farming' system is unavailable in the literature.

Therefore, given these backdrops, the principal aim of this paper is to examine the dynamics and factors influencing women's gainful employment in conjunction with male employment in 'gher' farming system over time in Bangladesh. The specific objectives are to: (a) examine trends in employing female and male labour in prawn–carp and HYV Boro rice enterprises of the 'gher' farming system; (b) examine trends in real wage, wage gap and the cost of employing female and male labour in each enterprise; (c) explore evidence of jointness in the decision to employ female and male labour in each enterprise; and (d) jointly identify the socio-economic determinants of employing female and male labour in each enterprise. We do this by using a unique set of farm-level panel data of a cohort of 90 farmers covering a 14-year period (2002–2015) from a typical 'gher' farming village of southwest Bangladesh.

The contributions of this study to the existing literature are as follows. First, we provide a detailed examination of trends in women's gainful employment and associated returns from 'gher' farming system over time. Second, we explicitly investigate whether the decision to employ female and male labour in each enterprise of the 'gher' farming system is correlated, which if true will

point towards the need to address the issue holistically. And third, jointly identify the socio-economic determinants of employing female and male labour while allowing for the possibility of the producer to make such decisions for any one or both enterprises at the same time. This is because agricultural enterprises are businesses where decisions are made and implemented exclusively by the producer under a wide range of external pressures than any other businesses (Groenewald, 1987; Errington, 1991). Therefore, such a complex decision making process cannot be realistically accommodated by examining factors influencing female and male labour use in each enterprise of the 'gher' farming system separately. This joint analytical approach provides a closer approximation of the true decision making behaviour of the producers. The results of this study is expected to be a valuable source of information for policy makers and relevant stakeholders engaged in promoting women's gainful employment in Bangladesh and elsewhere characterised by similar socio-economic circumstances.

2. Methodology

2.1. Study area and the data

The study is based on a unique set of farm-level panel data of 90 farmers covering a 14-year period (2002–2015) collected from Bilpabla village located in southwest Bangladesh. This village was selected purposively because the 'gher' farming system has been practiced here for a long time. Bilpabla is a typical village of Dumuria upazila (sub-district) of Khulna District, which is located 310 km south of the capital city Dhaka. Bilpabla shares similar demographic characteristics of other villages dominated by 'gher' farming. A total of 90 'gher' farmers were randomly selected from a total of 410 farmers during the first year of data collection in 2002. The first survey was conducted for a period of six months from November 2001 to April 2002. Since then, the same set of 90 farmers were surveyed every year until 2015, therefore providing a unique cohort of 90

famers over a 14-year period bringing the total sample size to 1260 observations. The initial surveys (i.e., from 2002 to 2008) were funded by Monbusho PhD Scholarship and subsequent JSPS Post-Doctoral Fellowship of the Government of Japan awarded to the co-author of this study. The subsequent surveys (2009 to 2015) were funded by academic allowances of the co-author's employing institution in Bangladesh. Data include detailed information on outputs produced and inputs used in the production process including use of hired and family supplied female and male labour in each enterprise, i.e., prawn–carp and HYV Boro rice enterprises.

2.2 Variables

The amount of hired female and male labour days used in prawn–carp and HYV Boro rice enterprises per farm over time were specified as the set of dependent variables. The study only focuses on hired female labour because the focus of this study is to examine women's gainful employment in 'gher' farming system.

2.2.1 Explanatory variables: Prices and socio-economic factors

The 'gher' farming system uses a wide range of inputs. The prawn–carp enterprise used a total of 16 inputs and HYV Boro rice enterprise used 11 inputs which were grouped as appropriate in order to reduce the number of key variables to be entered in the econometric models. Also all current prices of inputs and outputs were converted to real prices using national income deflator of Bangladesh to take away the influence of inflation from the data. As such, all prices were converted to constant 2006 prices so that any change observed in the data series reflect real change. The variables included in the four reduced form labour demand functions were: (a) output prices –

prawn output price[1] (BDT per kg) in prawn–carp enterprise and rice price (BDT per kg) in HYV Boro rice enterprise functions; (b) input prices in HYV Boro rice enterprise are: weighted average of female and male labour wages in HYV rice production (BDT per day); weighted average price of fertilizers (BDT per kg) (i.e., urea, Muriate of Potash, Triple Super Phosphate, and gypsum); HYV rice seed price (BDT per kg); machineries (BDT per ha); and pesticides (BDT per ha); (c) input prices in prawn–carp enterprise were: weighted average of female and male labour wages (BDT per day) for prawn–carp production; prawn fingerling price (BDT per 1000 fingerling); carp fingerling price (BDT per kg); fish meal price (BDT per kg); snail price (BDT per kg); price of cereals (BDT per kg) (i.e., computed as weighted average prices of broken rice, wheat bran, vermicelli, flat rice and pulses); price of lime (BDT per kg); and price of rotanon chemical (BDT per kg); (c) a set of socio–economic factors in both enterprises which include cultivated land (ha) (i.e., total 'gher' area in prawn–carp enterprise and actual rice area in HYV Boro rice enterprise); education level of the producer (i.e., completed year of schooling), family size (i.e., number of family members per farm); and experience of the producer (i.e., age in years).

Output prices have a direct influence on the profits derived from the enterprises and producers are expected to respond to output price changes when deciding on the use of inputs including labour (Rahman, 2000). Therefore, respective output prices were included in the labour demand functions of each enterprise of the 'gher' farming system. Apart from labour, other major inputs in HYV rice production are fertilizers, seed, machinery and pesticides, which contribute significantly to the production costs and may have either a substitution or complementary

[1] The carp price was not included because revenue from carp was not critical in gher farming system as only 5.3% of gross revenue of the prawn–carp enterprise was contributed by carp production (Rahman et al., 2011).

relationship with labour demand (Rahman, 2000). Producers seeking to maximize profits from HYV Boro rice production are expected to respond to changes in input prices and adjust their use of inputs accordingly including changing the amount of hired female and male labour used in response to change in wages (Rahman, 2000). Therefore, labour wage, prices of fertilizers, HYV rice seeds, machineries and pesticides were included in the female and male labour demand functions of HYV Boro rice enterprise.

Similarly, producers use a wide range of inputs in the prawn–carp enterprise mainly to boost prawn production whereas carp production also adds substantially to the profit. Except fingerlings of prawn and carp, majority of the inputs are feed ingredients for prawn and the two types of chemicals (lime and rotanon) are used to protect the 'gher' farm from disease and pest attacks. As with the case of rice production, profit maximizing producers are expected to respond to input prices and adjust their input use for prawn–carp enterprise as well including labour use in response to change in wage.

Among the socio-economic factors, farm operation size was found to have significant influence on labour use (Rahman and Routray, 1998; Rahman, 2000). Experience/age and the level of education of the producer are common explanatory variables used to explain labour demand (e.g., Rahman and Routray, 1998; Rahman, 2000; Hossain et al., 2012; Shaheen et al., 2015). For example, education serves as a proxy for various factors. Access to information and the capability to understand technicalities related to farming may have an influence on enterprise choices and the use of labour in each enterprise (Rahman and Routray, 1998; Rahman, 2000). Similarly, farmer's age was included to take into account the experience of the producer in decision-making related to female and male labour use in each enterprise.

Family size was included in the labour demand functions because large household size

imply additional labour availability from the family, which may adversely influence hired female and male labour demand (Rahman and Routray, 1998; Rahman, 2000). Shaheen et al. (2015) hypothesized household size to be negatively related to female labour participation in paid employment. Finally, time variable is used to econometrically confirm whether demand for female and male labour is increasing in each enterprise of the 'gher' farming system over time or not.

2.3. Theoretical framework and the econometric model

Figure 1 presents the conceptual diagram of the factors influencing hiring female labour in 'gher' farming system. The prawn-carp enterprise is labour intensive as compared to HYV boro rice enterprise (see Table 1). The demand for labour for each enterprise can be fulfilled either by supplying male and female members from the family and/or hiring male and female labour from the market. The decision to hire female labour is assumed to be influenced by wage of female labour in the market, 'gher' operation size, education level of the producer, family size and the category of the farms (i.e., small, medium or large farms).

The theoretical framework is based on a production model with profit maximizing behaviour of the 'gher' producers following Rahman (2015). The model starts with specifying two variable input vectors: labour, L and 'other inputs', Z, and one fixed input of 'gher' area, G to operate n number of enterprises ($i = 1 \ldots N$) where G_i is 'gher' area allocated to the i^{th} enterprise in year t ($t = 1, \ldots. T$).

A typical farmer j maximizes total profits as follows:

$$\sum_{i=1}^{n} p_{it} Q_{ijt} - \sum_{i=1}^{n} w^{Q} L_{ijt} - \sum_{i=1}^{n} w^{O} Z_{ijt}$$

$$s.t. Q_{ijt} = f\left(L_{ijt}, Z_{ijt}, G_{ijt}, S_{jt}\right) for\ i = 1, \ldots. N\ and\ t = 1 \ldots. T \qquad (1)$$

$$\text{and } \sum_{i=1}^{n} G_{ijt} \leq G_{jt} \qquad (2)$$

where p_{it} is the price of individual output in year t; Q_{ijt} are the quantity of outputs from prawn-carp and HYV Boro rice enterprises in year t; w^Q is the vector of wages for male and female labour in each enterprise in year t; L_{ijt} are the labour inputs in each enterprise in year t; w^O is the vector of prices of 'other variable inputs' in year t; Z_{ijt} are the 'other inputs' in each enterprise in year t in Equation (1) and $G_{jt} = G_{1jt} + ... + G_{njt}$ are the land area under each enterprise in year t in Equation (2).

Equation (1) represents production function of each enterprise i produced by farmer j in year t. The production function Q depends on the use of labour (L) and 'other variable inputs (Z's)' in that enterprise, land area within 'gher' (G) allocated and some exogenous socio-economic variables (S_j) which shift the production function each year. Equation (2) provides the condition that the allocation of land to various enterprises must be either equal or less than the total 'gher' area under operation each year for farmer j.

The first order conditions provide the demand functions for labour and 'other inputs' for each enterprise:

$$Q_{jt} = Q_{jt}\,(w^Q,\ w^O,\ p_{1t}\ldots\ p_{nt},\ G_{1jt}\ \ldots,\ G_{njt},\ S_{jt}) \qquad (3)$$

$$O_{jt} = O_j\,(w^Q,\ w^O,\ p_{1t}\ldots\ p_{nt},\ G_{1jt}\ \ldots,\ G_{njt},\ S_{jt}) \qquad (4)$$

where p's and w's are the prices of outputs and inputs; G's are land area within gher and S's are socio-economic variables in Equations (3) and (4).

We assume separability of inputs of labour on one hand and all 'other inputs' on the other, which therefore allows separate estimation of the labour demand function[2].

[2] Individual estimation of factor demand functions utilizing separability assumption has been widely used in empirical studies (e.g., Beneito et al., 2001; Rahman, 2015).

2.4. The empirical model: a multivariate Tobit approach

Because all producers do not use hired female labour in any one or both enterprises (columns 2 and 7 in Table 1), estimating Eq. (3) with Ordinary Least Squares regression procedure will lead to biased and inconsistent estimates because there will be zero values for the dependent variable for some observations. Therefore, we present a multivariate Tobit model, which allows for zero observations on hired female labour use by some producers on each enterprise and also enables to identify jointness in the decision to hire female and male labour in any one or both enterprises.

We state that producers make sequential decisions; first 'whether to hire female labour in a specific enterprise or not'; and second, conditional on hiring, 'the level/intensity of hiring?' The use of a censored regression model is appropriate to address these questions. Therefore, a Tobit model is most appropriate because it uses all observations, which are at the limit, often zero (e.g., not hiring female labour), and which are above the limit (e.g., hiring female labour), in the estimation process unlike other methods which use observations only above the limit (McDonald and Moffit, 1980). The Tobit model also identifies underlying level of intensity of potential producers who do not use hired female labour in a specific enterprise. For example, the proportion of producers hiring female labour ranges from 67.8–80% in prawn-carp enterprise and 48.9–68.9% in HYV Boro rice enterprise (columns 2 and 7 in Table 1). In other words, 20.0–32.8% and 31.1–51.1% of the producers did not hire female labour in prawn-carp enterprise and HYV Boro rice enterprise, respectively.

Let the outcome function for the use of hired female labour in a particular enterprise in year t (measured as person days) be given by:

$$L_{it}^{*} = \gamma' X_{it} + \mu_{it} \qquad (5)$$

where X_{it} is the vector of regressors, γ is the vector of parameters to be estimated, and μ_{it} is the

error term. For producers hiring female labour in prawn–carp enterprise, L_{it}^{*} equals the actual number of female labour hired (L_{it}) in year *t*. For those who are not hiring female labour in prawn–carp enterprise L_{it}^{*} is an index reflecting potential hiring such that:

$$\begin{aligned} L_{it} &= L_{it}^{*} \quad if\ \gamma' X_{it} + \mu_{it} > 0 \\ &= 0 \quad if\ \gamma' X_{it} + \mu_{it} \le 0 \end{aligned} \qquad (6)$$

The advantage of the Tobit model as in Eq (6) is that it captures the decision to hire female labour as well as the intensity or number of person days hired, whereas a probit model will provide information on the decision to hire female labour only.

Since we see that a substantial proportion of producers hired female labour in any one or both enterprises (Tables 1) in addition to hiring male labour, we postulate a multivariate Tobit model in order to capture this phenomenon of joint outcome:

$$\begin{aligned} &L_{1it}^{*} = \gamma' X_{1it} + \mu_{1it} \\ &L_{1it} = Maximum(L_{1it}^{*}, 0) \quad (the\ usual\ Tobit\ specification\ as\ in\ 6). \\ &L_{2it}^{*} = \gamma' X_{2it} + \mu_{2it} \\ &L_{2it} = Maximum(L_{2it}^{*}, 0) \quad (the\ usual\ Tobit\ specification\ as\ in\ 6). \\ &L_{3it}^{*} = \gamma' X_{3it} + \mu_{3it} \\ &L_{3it} = Maximum(L_{3it}^{*}, 0) \quad (the\ usual\ Tobit\ specification\ as\ in\ 6) \\ &.L_{4it}^{*} = \gamma' X_{4it} + \mu_{4it} \\ &L_{4it} = Maximum(L_{4it}^{*}, 0) \quad (the\ usual\ Tobit\ specification\ as\ in\ 6) \\ &\mu_{ii}, \mu_{2i}, \mu_{3i}, \mu_{4i} \approx N[0,0,0,0, \sigma_1^2, \sigma_2^2, \sigma_3^3, \sigma_3^4 \rho_{12}, \rho_{13}, \rho_{14}, \rho_{23}, \rho_{24}, \rho_{34}] \end{aligned} \qquad (7)$$

where L_{1it}^{*} denotes use of hired female labour by the *i*th producer in year *t* in HYV Boro rice enterprise; L_{2it}^{*} denotes use of hired male labour by the *i*th producer in year *t* in HYV Boro rice enterprise; L_{3it}^{*} denotes use of hired female labour by the *i*th producer in year *t* in prawn–carp enterprise; L_{4it}^{*} denotes use of hired male labour by the *i*th producer in year *t* in prawn–carp enterprise; and ρ_{mn} is the correlation between the error terms μ_{mit} and μ_{nit} where *m, n* = 1, 2, .. 4. The distributions are independent if and only if all $\rho_{mn} = 0$.

Our modelling framework allows us to accommodate producer's decision to use hired female labour in any one or both enterprises in addition to hiring male labour. It also enables us to identify whether the decision to hire female and male labour in each enterprise is related or not. Also this multivariate approach is more efficient as compared to the conventional univariate approach (i.e., single equation Tobit model) because it nests individual univariate models as well as provides evidence of jointness in decision making by estimating correlation between the error terms of these models.

We use the program code developed by Barslund (2007) in Stata V10 software (Stata Corp, 2007) to estimate our model, which involves maximization of the simulated likelihood function using a standard Maximum Likelihood procedure (for details, please see Rahman and Akter, 2014).

3. Results and discussion

3.1. Trends in women's gainful employment in 'gher' farming system

Trends in labour input used for prawn–carp and HYV Boro rice enterprises, classified by gender and sources of supply, over the 14-year period (2002–2015) are presented in Table 1. Several interesting insights could be drawn from Table 1. It is clear from Table 1 that the proportion of producers hiring female labour is substantially higher in prawn–carp enterprise as compared to HYV Boro rice enterprise. The proportion of producers hiring female labour ranges from 67.8–80% in prawn-carp enterprise which is higher than the range 48.9–68.9% in HYV Boro rice enterprise (columns 2 and 7 in Table 1).

However, actual use of hired female labour as a percentage of total hired labour was substantially low in prawn–carp enterprise as compared to HYV Boro rice enterprise. For example, the share of hired female labour use varied within a range of 7–9% of total hired labour use per ha in prawn–carp enterprise as compared to 15–21% in HYV Boro rice enterprise (columns 4 and 10

in Table 2). In contrast, share of family female labour in prawn–carp enterprise is substantially higher, estimated at 72–76% of the total family labour use per ha, as compared to 33–43% in HYV Boro rice enterprise (columns 7 and 13 Table 2). The implication is that although women are hired in both enterprises, their participation rate is still substantially lower than hired male labour and particularly low in prawn–carp enterprise. The shortfall in labour use is filled by utilising family female labour. The level of male labour supplied from the family is also quite low. It is however, encouraging to note that the use of hired female labour per ha grew significantly at the rate of 2.1% per annum in prawn–carp enterprise (Table 1). The use of female labour as a proportion of total labour used in 'gher' farming system as a whole varies between 22.8–24.8% over time (calculated from information presented in Table 2).

In HYV Boro rice enterprise, use of hired male labour grew significantly at the rate of 1.2% per annum instead while the use of family female labour grew significantly at the rate of 1.7% indicating increased burden of family female labour in 'gher' farming system. The actual level of hired female labour reported here is substantially higher than those reported by Rahman (2000) implying that women's gainful employment is increasing gradually in Bangladesh agriculture, which is highly encouraging. Also, these estimates of women's total labour input (hired and family supplied) in 'gher' farming system is higher than the estimates of Rahman and Routray (1998) and Rahman (2000). In contrast, Ahmed et al. (2013) reported that the share of female labour use in rice production ranges between 1.0–3.5% only in the FTF zone. However, the share of female labour in rice post-harvest activities was substantially higher ranging between 22.1–41.6% (Ahmed et al., 2013), thereby, reinforcing the conventional view of women's dominant involvement in the post-harvest activities in Bangladesh (Rahman, 2000).

Table 3 presents the mean level of female and male labour wage at constant 2006 prices in

each enterprise over time. It is clear from Table 2 that real wage of female labour grew significantly at the rate of 4.3% and 2.2% per annum in HYV Boro rice and prawn–carp enterprises, respectively over the 14-year period. Also the wage gap between female and male labour had reduced substantially over time from 20–22% in 2002 to 8–15% in 2015 and the reduction in wage gap was substantially higher in the HYV Boro rice enterprise estimated at 8.2%. Ahmed et al. (2013) reported average daily wage rate for male and female labour at BDT 220.3 and BDT 199.9 in the FTF zone of Bangladesh for the year 2011/12, which implies a wage gap of 9.3% which is very close to our estimate. Rahman and Routray (1998) reported a wage gap of 11.5% for the year 1989 in the sampled villages of Bangladesh. Rahman and Islam (2013), based on data from Household Income and Expenditure Survey of Bangladesh for the year 2010, noted a wage gap of 15.6% between female and male labour, an improvement from the past decade, which they attributed to the tightening of the casual labour market. All these supporting evidence shows that wage gap between female and male labour has declined overall.

Table 4 shows that the real cost of hiring female labour per ha grew significantly at the rate of 4.5% and 4.2% p.a. in HYV Boro rice and prawn–carp enterprises mainly due to increased use of female labour per ha and growth in female wage implying that women are benefiting from 'gher' farming. Furthermore, the level of benefit accrued to women in terms of paid wage is increasing significantly over time although the relative level of gain is still small as compared to men. The family supplied female labour cost reported in Table 4 also demonstrated real growth over time for both enterprises, but this does not necessarily reflect women's gainful employment because this cost was imputed using market wage. It is interesting to note that the cost of hiring male labour did not grow over time in the prawn–carp enterprise because producers offset increase in actual number of total labour use by either hiring more female labour or supplying female labour from the family,

thereby pointing towards increased involvement of women in 'gher' farming system.

3.2. Joint determination of factors influencing gainful employment of female and male labour in 'gher' farming system

Table 5 presents joint parameter estimates of the female and male labour demand functions of each enterprise of the 'gher' farming system. Since the parameter estimates of the multivariate Tobit model cannot provide correct magnitude of influence, the corresponding elasticities are presented in Table 6. Among the total 50 coefficients on the variables, 52.0% of them are significantly different from zero. The main hypothesis that the 'correlation of the error term between each pair of equation is zero {i.e., $\rho_{jk} = 0$}' is rejected at the 1% level of significance for all six pairs, thereby justifying use of our multivariate Tobit approach. The result of the Likelihood Ratio test at the last row of Table 5 also confirmed that the decision to employ female and male labour in both enterprises are correlated. However, the nature of correlation is not uniform across the labour demand functions. For example, the significant positive correlation between female labour demand in HYV rice and prawn–carp enterprise implies that the unobservable factors which are positively related to the probability of hiring female labour in HYV rice also positively related to the probability of hiring female labour in prawn–carp enterprise. Similarly, the negative correlation between female labour demand in HYV rice enterprise and male labour demand in prawn–carp enterprise implies that the unobservable factors which increase the probability of hiring female labour in HYV rice also significantly reduces the probability of hiring male labour in prawn–carp enterprise. These particular set of information can be exploited in prescribing appropriate policy instruments in order to promote women's gainful employment in 'gher' farming system.

Output price is a significant determinants of female labour demand in HYV Boro enterprise and have an elastic response (Table 6). The magnitude of response is very high for rice price

(elasticity value 10.53) implying that a 1% increase in rice price will increase hired female labour demand by 10.53%. These finding conform to Rahman (2000) who reported positive influence of rice and jute prices on hired female labour demand in Bangladesh. The prawn price also has a positive elastic response in the prawn-carp enterprise but the coefficient is not significantly different from zero. The influence of rise in real wages in depressing female labour demand in both enterprises is strong and highly elastic, consistent with theory. The responsiveness is highest for HYV rice enterprise (elasticity value –5.77 implying that a 1% increase in real wage will reduce female labour demand in HYV rice enterprise by 5.77%. Rahman (2000) and Rahman et al. (2012) also reported negative influence of wage on female labour demand and overall labour demand in farming in Bangladesh, respectively.

Producers treated fertilizers as substitutes for both hired female and male labour in HYV rice enterprise with elastic response for female labour estimated at 2.05% (Table 6). The implication is that producers tend to substitute use of both types of labour with fertilizers in HYV rice enterprise. Rahman et al. (2012) found organic manure as substitute for labour demand with insignificant role of inorganic fertilizers in Bangladesh agriculture. Producers also treated seeds and pesticides as complements for hired female labour in HYV rice enterprise. Similarly, producers treated cereal as substitute for male labour demand in the parwn-carp enterprise (Table 5).

The influence of socio-economic factors on hired female and male labour demand varied between the two enterprises of the ‘gher’ farming system. In general, the likelihood of hiring female labour increases with cultivated area in both enterprises and the responses are highly elastic (Table 6). Similar response was observed for hired male labour demand but the magnitude of responsiveness is lower than the hired female labour demand. The reason for hiring more female labour as cultivated area increases may be to reduce total cost of hired labour since wage of female

labour is 15–22% lower than wage of male labour (Table 3). Rahman (2000) and Rahman et al. (2012) also reported positive influence of the amount of land owned on female and male labour demand and overall labour demand in farming in Bangladesh, respectively. Educated producers used more hired female labour in both enterprises along with hired male labour, which conforms with the findings of Rahman (2000).

Large family size decreases the likelihood of hiring female labour (elasticity value –2.00) and male labour (elasticity value –0.32) in HYV rice enterprise consistent with expectation. Rahman (2000) also noted negative influence of the number of working members in the family with hired male labour as well as total labour demand. Shaheen et al. (2015) and Hussain et al. (2012) noted significant negative influence of household size on female employment in Pakistan. However, in contrast, higher family size increases the likelihood of hiring male labour in prawn–carp enterprise albeit with a low elasticity value of 0.08% (Table 6).

Experienced farmers use significantly hire more female labour in both enterprises along with male labour (Table 6). The elasticity value is highest and in the elastic range for hired female labour demand in HYV Boro rice enterprise estimated at 2.32.

Finally, the demand for hired female labour is increasing significantly over time in both enterprises, which econometrically confirmed the observations made in Table 2. The rate of increase is substantially higher in HYV rice enterprise (elasticity value 1.23) as compared to prawn–carp enterprise (elasticity value 0.36), thereby indicating that women's gainful employment in 'gher' farming system is increasing significantly over time (Table 5).

4. Conclusions and Policy Implications

The principal aim of this study was to examine trends in women's gainful employment in 'gher' farming system and jointly identify the determinants of employing female labour while allowing

for the possibility of hiring male labour at any one or both enterprises (i.e., prawn–carp or HYV Boro rice enterprises) at the same time by applying a multivariate Tobit model on a unique farm-level panel data of 90 producers covering a 14-year period (2002–2015) from southwest Bangladesh.

Results revealed that women's gainful employment and real wage have increased significantly with substantial reduction in wage gap over time, thereby confirming that women are benefiting from this highly profitable and yet labour intensive farming system. Salma and McGilllivray (2015) noted that the gender gap in wages in Bangladesh has decreased by 31% during 1999–2009. The latest available Labour Force Survey of Bangladesh 2013 reported monthly wage/salary in agricultural/forestry sector is BDT 8,938 for female and BDT 9,856 for male, respectively which shows a wage gap of 9.07% (LFS, 2015) which is remarkably close to the wage gap of 8.0% in HYV Boro enterprise in 2015 (Table 3).

The decision to employ female labour in both enterprises was found to be positively correlated, implying that producers who hire female labour in any one enterprise also employ female labour in the other enterprise, thereby synergistically increasing women's gainful employment. Similarly, the negative correlation between female labour demand in HYV rice enterprise and male labour demand in prawn–carp enterprise implies that producers hiring female labour in HYV rice enterprise are likely to reduce hiring male labour in prawn–carp enterprise, which has resulted in increasing women's involvement in the latter enterprise. Among the determinants, increase in output prices, cultivated area, education and experience of the producer significantly increases demand for female labour whereas a rise in wage and family size significantly reduces demand as expected. Results also confirmed that female labour demand has increased significantly over time.

The following policy implications can be drawn from the results of this study. Investment in education targeted at 'gher' farming population will improve women's gainful employment. Literacy rate in Bangladesh is increasing and is estimated at 57.7% in 2010 (BBS, 2011). This rise is partly due to adult literacy programs operated by the government of Bangladesh from the 1980s, strengthening of public primary education system and thousands of primary schools operated by BRAC as well as other NGOs (Rahman and Rahman, 2014). In this context, the Ministry of Education can play an important role to create educational opportunities targeted at the 'gher' farming population. Furthermore, existing adult literacy program can be targeted effectively for the 'gher' farmers by utilising easily accessible and cheap mobile phone technologies. Next, investment is needed in land and tenurial reforms aimed at consolidating average 'gher' operation size through smooth operation of the land rental market as well as effective regulation and implementation of existing tenancy acts and laws which will synergistically increase women's gainful employment along with men. Both Alam et al. (2014) and Rahman and Salim (2013) emphasized land reform measures to consolidate farm size in Bangladesh. The average farm size in Bangladesh has been falling steadily from 1.4 ha in 1960 to 0.60 ha in 2008 (Rahman and Salim, 2013). The average 'gher' operation size of the sampled farms is estimated at 0.54 ha which is very close to the national average of 0.60 ha.

Although the challenge to realize these policy measures are formidable but increasing women's gainful employment is important in order to promote inclusive growth (Kabeer et al., 2013) as well as reduce poverty (Rahman and Islam, 2013) as women make up 33.5% of the total active labour force in Bangladesh (LFS, 2015). Therefore, it is a goal worth pursuing.

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Ethical Approval: "This article does not contain any studies with animals performed by any of the authors."

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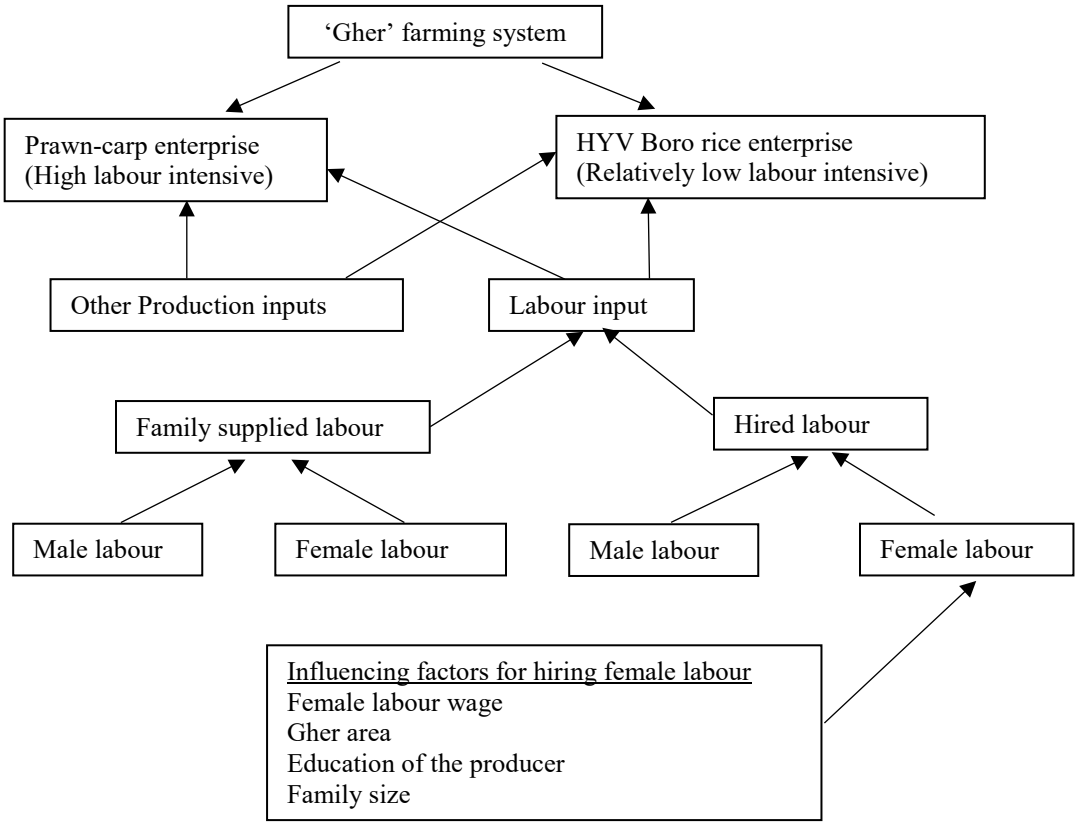

Figure 1. Conceptual framework of factors influencing hired female labour in 'gher' farming system

Table 1. Trends in gender composition of labour use in ‘gher’ farming system in Bangladesh

Year	Prawn–carp enterprise					HYV Boro rice enterprise				
	Percent of producers hiring female labour (%)	Hired female labour (days/ha)	Hired male labour (days/ha)	Family female labour (days/ha)	Family male labour (days/ha)	Percent of producers hiring female labour (%)	Hired female labour (days/ha)	Hired male labour (days/ha)	Family female labour (days/ha)	Family male labour (days/ha)
2002	66.70	24.96	329.08	88.90	27.53	57.80	17.62	90.95	24.57	46.88
2003	71.10	24.34	314.36	90.19	29.93	62.20	17.93	94.33	24.64	51.13
2004	67.80	24.44	334.99	88.11	28.02	65.60	21.27	92.39	25.85	47.83
2005	73.30	24.76	335.60	84.45	28.89	68.90	24.11	90.16	29.49	48.97
2006	66.70	24.96	328.07	85.87	29.17	48.90	15.25	100.54	26.92	49.97
2007	66.70	27.02	374.59	87.48	31.97	54.40	17.94	99.86	30.52	54.73
2008	75.60	25.41	320.54	76.83	28.39	61.10	21.48	102.53	31.73	48.57
2009	75.60	28.55	327.33	71.66	27.70	64.40	23.79	106.37	35.14	46.96
2010	67.80	24.56	318.69	78.37	29.19	48.90	16.35	100.18	27.83	50.22
2011	67.80	25.15	313.25	80.87	31.13	53.30	17.90	99.96	32.52	53.17
2012	66.70	29.62	344.18	88.89	30.13	54.40	21.62	105.39	31.76	51.30
2013	70.00	31.55	340.51	89.65	30.44	54.40	22.42	111.33	32.09	51.80
2014	67.80	29.57	354.32	93.41	28.49	54.40	18.59	103.46	29.78	48.28
2015	80.00	33.68	351.57	78.13	27.25	57.80	18.20	102.28	29.59	45.92
Growth rate (%)		2.10***	0.40	–0.30	0.10		0.30	1.20***	1.70***	0.01

Note: *** Significant at 1% level ($p<0.01$),

Table 2. Share of hired and family supplied female labour in total labour use in 'gher' farming system in Bangladesh

Year	Prawn-carp enterprise						HYV Boro rice enterprise					
	Hired female labour (days/ha)	Total hired labour (days/ha)	Share of hired female labour (%)	Family female labour (days/ha)	Total family labour (days/ha)	Share of family female labour (%)	Hired female labour (days/ha)	Total hired labour (days/ha)	Share of hired female labour (%)	Family female labour (days/ha)	Total family labour (days/ha)	Share of family female labour (%)
2002	24.96	354.04	0.071	88.90	116.43	0.764	17.62	108.57	0.162	24.57	71.45	0.344
2003	24.34	338.70	0.072	90.19	120.12	0.751	17.93	112.26	0.160	24.64	75.77	0.325
2004	24.44	359.43	0.068	88.11	116.13	0.759	21.27	113.66	0.187	25.85	73.68	0.351
2005	24.76	360.36	0.069	84.45	113.34	0.745	24.11	114.27	0.211	29.49	78.46	0.376
2006	24.96	353.03	0.071	85.87	115.04	0.746	15.25	115.79	0.132	26.92	76.89	0.350
2007	27.02	401.61	0.067	87.48	119.45	0.732	17.94	117.80	0.152	30.52	85.25	0.358
2008	25.41	345.95	0.073	76.83	105.22	0.730	21.48	124.01	0.173	31.73	80.30	0.395
2009	28.55	355.88	0.080	71.66	99.36	0.721	23.79	130.16	0.183	35.14	82.10	0.428
2010	24.56	343.25	0.072	78.37	107.56	0.729	16.35	116.53	0.140	27.83	78.05	0.357
2011	25.15	338.40	0.074	80.87	112.00	0.722	17.90	117.86	0.152	32.52	85.69	0.380
2012	29.62	373.80	0.079	88.89	119.02	0.747	21.62	127.01	0.170	31.76	83.06	0.382
2013	31.55	372.06	0.085	89.65	120.09	0.747	22.42	133.75	0.168	32.09	83.89	0.383
2014	29.57	383.89	0.077	93.41	121.9	0.766	18.59	122.05	0.152	29.78	78.06	0.382
2015	33.68	385.25	0.087	78.13	105.38	0.741	18.20	120.48	0.151	29.59	75.51	0.392

Table 3. Trends in real wages (BDT per day in constant 2006 prices) of hired female and male labour in 'gher' farming system in Bangladesh

Year	Prawn–carp enterprise			HYV Boro rice enterprise		
	Female wage	Male wage	Wage gap (%)	Female wage	Male wage	Wage gap (%)
2002	97.79	125.73	0.22	111.76	139.70	0.20
2003	106.92	133.65	0.20	120.29	147.02	0.18
2004	115.40	153.87	0.25	128.22	166.69	0.23
2005	122.03	183.04	0.33	158.63	195.24	0.19
2006	140.00	180.00	0.22	200.00	240.00	0.17
2007	140.88	178.45	0.21	216.02	253.59	0.15
2008	148.03	191.57	0.23	217.69	261.23	0.17
2009	154.96	187.59	0.17	220.21	260.99	0.16
2010	151.82	189.63	0.20	213.14	258.81	0.18
2011	155.27	183.50	0.15	211.73	247.02	0.14
2012	150.07	182.70	0.18	202.27	234.89	0.14
2013	146.11	170.46	0.14	194.81	231.34	0.16
2014	131.87	150.43	0.12	201.65	230.45	0.12
2015	125.29	147.08	0.15	207.70	226.25	0.08
Growth rate (%)	2.20***	1.00		4.30***	3.40***	

Note: *** Significant at 1% level ($p<0.01$),

Table 4. Trends in cost of hiring female and male labour in 'gher' farming system (BDT per ha at constant 2006 prices) in Bangladesh

Year	Prawn–carp enterprise				HYV Boro rice enterprise			
	Hired female labour cost	Hired male labour cost	Family female labour cost	Family male labour cost	Hired female labour cost	Hired male labour cost	Family female labour cost	Family male labour cost
2002	2440.46	41376.45	8693.41	3461.89	1969.35	12706.25	2746.42	6549.92
2003	2602.54	42015.79	9643.00	4000.23	2156.87	13868.65	2963.68	7517.32
2004	2820.74	51543.14	10167.41	4311.19	2727.37	15399.79	3313.95	7973.34
2005	3020.90	61428.55	10305.48	5288.36	3825.21	17602.97	4677.46	9560.76
2006	3493.77	59052.69	12021.53	5250.38	3050.09	24130.04	5383.14	11992.16
2007	3806.18	66846.64	12324.15	5705.98	3875.15	25324.96	6593.49	13877.95
2008	3760.79	61406.38	11372.80	5437.94	4675.99	26785.11	6907.00	12687.49
2009	4424.34	61402.44	11105.14	5196.12	5238.08	27760.98	7737.47	12256.66
2010	3720.57	60373.81	11930.61	5534.21	3485.09	25928.46	5932.42	12997.90
2011	3905.54	57481.68	12556.49	5713.09	3789.13	24690.79	6884.99	13133.74
2012	4444.54	62879.90	13339.76	5504.42	4372.73	24754.43	6424.52	12049.25
2013	4609.47	58043.64	13098.33	5188.78	4366.89	25755.60	6251.13	11982.73
2014	3887.33	53545.18	12114.36	4288.13	3749.52	23843.12	6005.03	11126.72
2015	4219.26	51710.41	9788.70	4007.58	3766.52	23401.37	2675.68	10030.72
Growth rate (%)	4.20***	1.40	1.80**	1.11	4.50***	4.60***	3.60*	3.40***

Note: *** Significant at 1% level ($p<0.01$),
** Significant at 5% level ($p<0.05$),
* Significant at 10% level ($p<0.10$).

Table 5. Joint determination of factors influencing female and male labour employment in 'gher' farming system: A multivariate Tobit model.

Variables	Symbols	HYV Boro rice enterprise		Prawn–carp enterprise	
		Hired female labour demand (L_1)	Hired male labour demand (L_2)	Hired female labour demand (L_3)	Hired male labour demand (L_4)
Intercept		-31.6249***	-45.2984***	-43.6918***	-87.5005***
Prices					
Output price	p	2.5305***	1.2194	0.0291	-0.1009
Wages	w_Q	-0.0956***	-0.0046	-0.2005***	0.0204
Fertilizer price	w_1	0.2567***	0.2051***		
Seed price	w_2	-0.0143***	0.0211		
Machine price	w_3	-0.0001	-0.0072		
Pesticide price	w_4	-0.0036*	0.0023		
Prawn fingerling price	w_5	--	--	0.0081	0.0110
Carp fingerling price	w_6	--	--	0.0537	-0.2650
Fish meal price	w_7	--	--	-0.5025	1.1100
Snail price	w_8	--	--	-0.1062	0.7799
Cereals price	w_9	--	--	-0.2233	1.3740***
Lime price	w_{10}	--	--	1.3885	1.5162
Rotanon price	w_{11}	--	--	0.0008	-0.0162
Socio-economic factors					
Land area under gher	G	24.7239***	126.9937***	59.0604***	347.7837***
Education of the producer	S_1	0.3811***	1.3700***	0.7181***	2.6681***
Family size	S_2	-1.6687***	-2.8047***	-0.2266	3.6007**
Age of the producer	S_3	0.1883***	0.2271***	0.2440***	0.7390***
Time	t	0.5821***	0.6940***	0.5799*	-0.5041
Model diagnostics					
Log likelihood		-19203.08			
Wald $\chi^2_{(58\ df)}$		10833.74***			
Correlation between the error terms					
$\rho_{(femrice,malerice)}$		0.1650***			

Variables	Symbols	HYV Boro rice enterprise		Prawn–carp enterprise	
		Hired female labour demand (L_1)	Hired male labour demand (L_2)	Hired female labour demand (L_3)	Hired male labour demand (L_4)
$\rho_{(femrice,\ femprawn)}$		0.3022***			
$\rho_{(femrice,maleprawn)}$		-0.0931***			
$\rho_{(malerice,\ femprawn)}$		0.1412***			
$\rho_{(malerice,maleprawn)}$		0.3695***			
$\rho_{(femprawn,maleprawn)}$		0.3864***			
Wald $\chi^2_{(6\ df)}$ (H_0: Correlation between pairs of disturbance terms are jointly 0)		584.613***			
Number of observations (N)		90			

Note: *** Significant at 1% level (p<0.01),
** Significant at 5% level (p<0.05),
* Significant at 10% level (p<0.10).

Table 6. Elasticities of the socio-economic determinants of female and male labour employment in 'gher' farming system.

Variables	HYV Boro rice enterprise		Prawn–carp enterprise	
	Hired female labour demand	Hired male labour demand	Hired female labour demand	Hired male labour demand
Prices				
Output price	10.5341***	0.4811	1.3376	-0.3073
Wages	-5.7781***	-0.0263	-2.7407***	0.0185
Fertilizer price	2.0473***	0.1551***		
Seed price	-1.1737***	0.1640		
Machine price	-0.0035	-0.0419		
Pesticide price	-0.2617*	0.0157		
Prawn fingerling price	--	--	1.5500	0.1389
Carp fingerling price	--	--	0.3117	-0.1018
Fish meal price	--	--	-0.9597	0.1406
Snail price	--	--	-0.1181	0.0573
Cereals price	--	--	-0.1962	0.0799***
Lime price	--	--	1.2161	0.0878
Rotanon price	--	--	0.0064	-0.0088
Socio-economic factors				
Land area under gher	2.3599***	1.1505***	2.6735***	1.0429***
Education of the producer	0.6861***	0.2341***	0.3774***	0.0929***
Family size	-2.0019***	-0.3194***	-0.0796	0.0835***
Age of the producer	2.3211***	0.2657***	0.8782***	0.1762***
Time	1.2381***	0.1400***	0.3601*	-0.0207
Number of observations (N)	90			

Note: *** Significant at 1% level ($p<0.01$),
** Significant at 5% level ($p<0.05$),
* Significant at 10% level ($p<0.10$).